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ABSTRACT

A conference was held to create further impetus in the direction of improving a "K-12-all-students-science-technology" delivery program. The proceedings of the conference are provided in this document. They include: (1) an introduction; (2) highlights of the keynote address by F. James Rutherford (suggesting that teachers take initiative for needed reforms); (3) excerpts from the "Report of the Governor's Commission on Science and Technology" for New Jersey (with recommendations concerning science and technology education); (4) summaries of seven papers (discussing what technological literacy really means, technological literacy and the science curriculum, "The Brain" high school materials, a funded New Jersey junior high/middle school science/technology teaching project, and other topics); (5) a description of the Science Teachers and Scientists Interaction Project; (6) summaries of discussion/brainstorming sessions (examining the nature of technological literacy, how and when to teach it, and how to utilize technology in teaching to best develop technological literacy); and (7) the National Science Teachers Association definition of scientific and technological literacy. (JN)

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CURRICULUM CONFERENCE

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SUMMARY REPORT

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TECHNOLOGICAL LITERACY AND THE SCIENCE CURRICULUM

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March 27, 1985
Xavier Center
College of St. Elizabeth
Convent Station, New Jersey

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1985 CURRICULUM CONFERENCE

TECHNOLOGICAL LITERACY AND THE SCIENCE CURRICULUM

March 27, 1985

Conference Co-Chairpersons

Marion Berkowitz
Joseph Kamsar

Registration Aides

James Gardner
Dorothy Lehmkuhl

Conference Co-Sponsors

New Jersey Science Supervisors Association
Trudy Iwanski, President

New Jersey Science Teachers Association
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INTRODUCTION

So much has been said about technological literacy. Just defining science and technology are difficult processes. The definition given by Dr. F. J. Rutherford of AAAS may be a start. "Science is something which tries to understand things. Technology is something that gets something done." Yet, without high technology, science learning at the cutting-edge will quickly halt today. Without applied science, as technology is sometimes defined, discovery will halt in many areas. Much technology has come to us via invention with little original science theory background.

Dr. Rustum Roy, Director of the Science/Technology/Society program at Penn State University, maintains that a lot has yet to be done and more fundamental research in some areas is needed for us to find the best way, the best materials, to teach technological literacy K-12. Dr. Rutherford believes that teachers need practical experiences for the improvement of science-technology teaching programs. He advocates we use our surroundings and utilize a hands-on block-time approach to teaching science-technology in our elementary schools.

This Conference has been a step in creating further impetus in the direction of the improvement of our K-12-all-students science-technology delivery program. We expect that the germination of ideas crystallized at this Conference and informal and formal meetings that follow will help; we expect that the spotlight will not dim on these needed goals of education. Comments from The Governor's Report on Science and Technology can help set these goals for each one of us. Dr. F. J. Rutherford's Keynote Address to the Conference can aid in setting the tone. Short comments from a report of the Science Teachers and Scientists Interaction Project (1984) will give us an example of one program in New Jersey where teachers are given the experiences to work in industry and then come back to the schools to develop materials for fellow teachers to use in the schools.

Other selected summary reports will stress a few specific areas of concern. The summary of our nine brainstorming groups will give us some additional questions and some specific recommendations to consider as we move forward.

J.K.

KEYNOTE ADDRESS HIGHLIGHTS

Dr. F. James Rutherford
Chief Education Officer
American Association for the
Advancement of Science

What is our definition of technological literacy? With the advance of technology and scientific knowledge, both of which are intertwined, the word literate has taken on new meanings. At one time, to be illiterate meant one could not read or sign one's name. Today literateness means a degree of understanding. The knowledge of history started as a verbal exercise. The technology allowed history to become permanent. Scribes were able to write history, the printing press provided means by which words could be within reach of anyone who could read them. Now technology, e.g., radio and TV, has made it possible for people to gain knowledge through the oral word again. Friendly computers even allow certain symbols to take the place of words. Public education relies very heavily on technology to produce "literate" students even as standards of literacy and degrees of mastery remain in change.

When we speak of improving literacy, we should have as a goal the improvement of thinking. We are not talking about tinkering with the curriculum as we did in the past by adding Driver Ed, Sex Ed, Drug Ed, and even Economic Ed. We need to educate so we produce people who can cope with the world as it is becoming. Our need is for awareness of the effects of nuclear reactors, environmental problems, the aquifers, spare parts, medicine, etc. We need thinkers, speculators, makers of innovative ways to use modern technology.

Modern technology is now applied science and science is applied technology. Technology: computers, microscopes, telescopes, etc. are needed to produce the knowledge base needed for the future. But we cannot tolerate the wrong mistakes. We must look at science and technology in a fresh way. We must think about what must be taught. In the past, curricula stressed learning to be applied to work and productivity. We will be poverty stricken if we look only at that. It is not enough to use science and technology only in terms of making money. We need to reexamine what we want, not just put in a course in technology, and we must look at issues in new ways.

The first seventeen years of life are important, precious. As educators, we must make these years more interesting. We cannot afford to have young people "drop out," to hide from personal contacts through the Walkman or the computer. Technology can be benign or negative. We need to be aware of this as we plan for students to be part of a participatory, democratic society.

We cannot change the schools just a little bit. Work must be from the ground up. Schools were fine forty years ago, but times have changed. At present, most of the calls for change have come from sources external to the system. We, as educators, must initiate the revolution and we are not doing so now. We need to know what we need to do. No machine can teach how to be together - live - work.

The world is changing. People who will be born soon must be able to think and understand science and technology. The need is not for more tests, courses, machines, etc., but for a real revolution - not bandaids.

Teachers should take the initiative for the true reforms needed. We must:

1. Revitalize teaching as a thing to do; as a profession. We lose all claims to special knowledge if teachers are reassigned to keep jobs. Teachers must be fully qualified in the field they teach. Fortunately, NSTA has taken a step in this direction.

   Teachers must have a voice in teacher quality: this is not gotten through teaching teachers, nor through a small stipend to a very few.

   We need to change terms of employment. Teaching should be a year long commitment with curriculum work and remedial and enrichment offerings built into the school year. This will cost. But it is essential.

   Administrative and technical support must be given to the teacher. Teachers should teach, not support the administration or fix the machinery.

2. Look at, sort, and rationalize curriculum. Our questions should not be what should we do in high school chemistry, but what should we do in twelve years of schooling. This reform must originate with the classroom teacher with support from universities and colleges.

3. Provide for modernization of education. We must take a new look from top to bottom. What technology is needed - provide it. We should refocus on the schools as a unit, not on individual teachers. Hold the schools responsible. Treat a principal like a coach: if he is not winning, fire him.

4. Capitalize any reform. We need to find out what we want to have kids learn and the ways to teach it. Then find the capital needed.

Finally, do not mislead kids about the nature of technology. If kids think the use of computers is technology, we are misleading them.

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EXCERPTS FROM THE REPORT OF THE GOVERNOR'S COMMISSION ON SCIENCE AND TECHNOLOGY

The Report Of The Governor's Commission On Science And Technology[1] for the State of New Jersey contained many recommendations concerning science and technology education. A number of these will be highlighted in this short report.

New Jersey is a center of technological innovation. It has more scientists and engineers per capita than any other state. Industrial expenditures for research and development in fields such as pharmaceuticals and electronics are the highest in the nation. Therefore, we should be a leader in the improvement of science and technology education K-12.

The Commission has reviewed the economic and educational variables that shape New Jersey's potential for industrial growth and found that the state has many advantages in its struggle for technology-based growth:

1. The state has a strong base of firms engaged in research and development, not only in pharmaceuticals and telecommunications, but also in such diverse fields as food technology and materials science.

2. There are more than 700 research and development laboratories in New Jersey.

3. Expenditures for research and development in pharmaceuticals and in electronics in New Jersey exceed expenditures in any other state.

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[1]Report Of The Governor's Commission On Science And Technology for the State of New Jersey: Edward E. Barr, Chairperson; Thomas H. Kean, Governor. CN 542, Trenton, N.J., 08625, 1983.

4. No other state has more scientists and engineers per capita than New Jersey, and our workforce includes 105,000 people engaged in research and development.

5. New Jersey firms invest billions of dollars in basic and applied research, the productivity of which can be assessed by the high rate at which patents are issued to New Jersey based firms.

6. New Jersey ranks third among states, behind California and New York, in the number of patents issued - second in the number of patents issued per capita.

7. New Jersey is a leading employer in what can be categorized as high technology industries - ranking seventh in the nation in high technology manufacturing jobs.

A successful science and technology strategy requires a workforce with a strong educational foundation. The Report states that without extensive reforms in education, we cannot hope to be a viable competitor in the technology race. Science and technology education must be a full K-12 endeavor. No simple bandaid answer can do the job: a commitment to the objective must permeate our curriculum.

Special recommendations of the Commission on K-12 education follow:

1. Highest priority must be given to the development of mechanisms to ensure that available school time is used more effectively, with maximum attention paid to rigorous academic subjects, including at least three years each of science and mathematics, and the equivalent of one-half year of computer science for all high school graduates. The report recommends "the assignment of far more homework than has generally been the case."

2. Strengthen public school curricula to better prepare students for the challenges of our rapidly changing technological society. This includes computer literacy and the improvement of "students' higher order verbal and math skills, such as problem solving." Science teachers in New Jersey have always had these objectives.

3. The system must be designed to benefit all students, not just the college bound.

4. Public and private sources should be tapped to ensure that schools have state-of-the-art capabilities. . . .

The Commission believes that investments in the education and technical skills of the labor force are as essential to economic growth as investments in plant and machinery. Technological change and the rapid specialization in economic activity among competing trading nations have dramatically escalated the demand for highly educated and skilled workers. Unfortunately, both in New Jersey and the United States, there is a widening gap between the quality of public education and the requirements of the marketplace.

As a result, the availability of skilled technical workers is sorely limited and may soon become a deterrent to industrial investment in New Jersey, particularly by technology-based companies. As economists Eli Ginsberg and George Vojta have written, "the skill, dexterity, and knowledge of the population . . . have become the critical inputs that determine the rate of growth of the economy." Without swift action by both government and business to improve the educational, technical, and professional skills of our workforce, New Jersey's economy faces perilous decline. Efforts need to be undertaken at all educational levels.

The Commission recommends the establishment of special statewide programs for academically gifted high school students in science, mathematics, and other fields. These initiatives should include the creation of specialized schools to serve the entire state, the design of new local or regional programs within existing schools, and financial incentives for superior programs already in place. While admission to these special programs should be based solely on academic qualifications, the overall program plan also must be designed to benefit all secondary students and schools in the state through outreach programs. These might include faculty exchanges, summer teacher institutes, and student seminars in satellite locations. Special emphasis should be placed on involving teachers from urban school districts. As precursors to full statewide strategies, establish pilot projects in selected schools to develop innovative uses for computers, video disks, and other new technologies in educational programming.

The NJSSA and NJSTA will continue to work toward the improvement of science and technology education in New Jersey with the aid of business, industry, The State Department of Education and The State Department of Higher Education, and many other interested and involved groups. We must prepare our students for a changing world.

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WHAT TECHNOLOGICAL LITERACY REALLY MEANS AND FOR WHOM

Presenter: Dr. Allen McClelland, Staff Administrator
Central Research and Development, E. I. Dupont

The quality of our science majors coming from colleges and universities is the best ever. There are no serious shortages here especially in the fields of life science and computer science. Areas that can be improved are writing skills, oral presentation, and accepting business needs.

Problems lie in the teaching of science for non-science majors. At the college level, it is hard to get experts to teach their particular science to students who need a less rigorous course. The professors have commitments to research or to producing majors. In high school, teachers are mindful of the Achievement Tests which only some of the students in any class are going to take.

In universities there is great rivalry between the science and education professors. The experts look down their noses at fields not their own to the detriment of a student who might like to combine French and science as the major and minor courses, for example. There is little cross-fertilization between the chemistry vs. chemical engineering curriculum, let alone between major fields.

There is need for another view. If teachers can look at their students as possibly being in one of the following categories, perhaps the students would be more technologically and scientifically literate:

1. The full time participant - professional.

2. The part time participant - amateur, involved in scuba diving, Maya archeology, politics, etc.

3. The active observer - appreciates music, dance, etc. by knowing the technical difficulties involved.

4. The non-involved - spectator sports, e.g.

The curriculum should be revised to meet the needs of all of these.

A science curriculum emphasizing technological literacy should include:

1. Practical use in daily life.

   Everyone should know how to change a light bulb or take care of an automobile so as to maximize its useful life.

2. What one should believe.

   The teaching of "facts" is not productive. Rather students should learn about the people and processes of science. Too often, teachers attempt to teach what they believe are facts, and in their zeal, lead students to believe that the atom is like a miniature solar system with the electrons like planets orbiting the nucleus, the sun. Or at a little higher level, teaching quantum mechanics without laying a foundation. Teaching misinformation is not what our curriculum should be about.

There are many crucial concepts which can be taught and discussed even at the elementary level, and surely, with greater depth at the upper levels.

One of these might be to collect data and interpret risk vs. benefit of certain practices, e.g., the 55 mile per hour speed limit. Or students might study the effect of various concentrations of Vitamin A on living animals - Can we have too much of a good thing?

Finally, every student should be aware of probability and statistics. Too often there is not a clear cut answer as to what will happen every time. Students will need to make decisions, even life threatening, on the basis of the calculated risk.

In summary, our students need to be prepared for a future we do not yet know, not necessarily for a profession we know today. They will need a practical background for that which we know as well as the ability to make wise decisions in new circumstances.

This is the challenge for producing a science curriculum for the future.

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TECHNOLOGY AND SOCIETY
TEACHING FOR TECHNOLOGICAL LITERACY

Presenter: **Dr. Emil Joseph Piel, Chairperson**
Department of Technology and Society
SUNY, Stony Brook

When looking at technology as a context for school science, it is useful to explore the points of view brought by various groups involved. The image seen by the general public is that of "America at risk." We need to catch up with Russia, with Japan, with Germany.

We desperately need more scientists and engineers. We are falling behind and the schools must change so we can catch up. The situation seen by science educators is that there is need for syntheses of these concepts into the whole of the science curriculum: decision making, modeling, systems - everything - everybody, feed back, and stability. Science educators want to know what research says to the science teacher. Their focus is on excellence. The third group, the students, view the situation in terms of what is important to them. They want fast foods, cars, telephones, stereo, television, and their own bodies.

Our problem is in finding how we can use the technology involved in the things students are interested in to teach the science we feel required to teach. Here are some ideas:

1. Cars - Teach a physics course around cars. Some topics included could be auto safety, police radar, F = ma, micro-processors, calculations of reaction time.

2. Telephone - A science mini-course can be built around the telephone. Some topics included could be fiber optics, reflection/ refraction, waves, hearing.

3. Stereo - Teach about sound and waves. Have students set up speakers to produce interference.

4. Bodies - Students have great interest in biochemistry and biophysics when taught through such topics as the artificial heart, vision and corneal implants, or the pacemaker. The science of electrical currents, Galvani's work, etc. are all essential to knowing how a pacemaker can prolong life. The list of applications of technology to the treatment of disease is very long.

5. Food - Topics suggested include irrigation, aquifers, water conservation, the chemistry of fertilizers and pesticides (including hazards in their preparation and application), hybrids, and genetic manipulation.

6. Decision Making - Students will need to consid[illegible] alternatives, to make trade-offs. They w[illegible] profit from considering probabilistic vs. deterministic models.

7. Today's Paper - What a textbook this can be. [illegible] is full [illegible]f information about problems caused by [illegible] capable of being solved by technology, both present and that yet to come.

The science educator looks to see how such programs can be implemented. We have among us blockers, shakers, and movers. The curriculum of tomorrow will depend upon the strength of conviction of the above when decisions are made.

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THOUGHTS ON TECHNOLOGICAL LITERACY AND THE SCIENCE CURRICULUM

Presenter: Dr. George S. Hammond, Executive Director Corporate Research, Allied Corporation

In order to discuss "Technological Literacy," we must first come to agreement as to what we mean by the term. If we can settle that issue, we should then try to decide whether or not it is something that we should seek to instill in all of our youngsters. Finally, we should probably address the question of "How to do it," if we believe that the whole show is worthwhile.

I do not believe that technological literacy requires the ability to read and comprehend the professional journals in the fields of science and engineering; nor do I think it includes even quasi-scientific publications such as Science, Nature, or professional trade journals. Probably closer to the target is Scientific American, but I am not really sure that this is the target that the organizers of this meeting had in mind; but let me check. How many of you read Scientific American regularly?

I think that what many people have in mind as scientific literacy is the ability to understand and evaluate scientific and technological references which they encounter in the public press. There is a desire that many thoughtful citizens be able to form some kind of semi-independent judgments on questions such as the Bohphal tragedy, the feasibility of Star Wars defenses, and the significance of binary chemical weapons.

I submit that those laudable ambitions are a tall order and ask what other entries in the public press are received by any wide audience with any reasonable degree of "literacy." I have been a sports fan most of my life and consider myself to be reasonably literate in the sports pages. However, the real cogniscenti know far more than I, and I believe that most people who read newspapers know far less about the subject. Most people are, in fact, total "sports illiterates." I admit to feeling so illiterate and not at home in the entertainment pages that I never read them; that is clearly one of my own areas of gross illiteracy. And so it goes: if we look carefully at the people of our country, or of our world, we are likely to conclude that most of us are "illiterate" in most areas of human knowledge and understanding. To me this means that

teaching our students in schools to be technologically literate is a tough job.

1. What is required to produce reasonable literacy?

   Consider my own experience in sports literacy and French language (now largely lost!).

   - Some interest in the subject.
   - Repeated and repetitive exposure.
   - The habit of spontaneous reading.

2. Problem of good teaching and teaching materials.

   - Quality of text books.
   - Problem of teachers who have some vocabulary and little understanding.
   - Current events.
   - Value of hands on? Concept of an experiment.

3. Can literacy be learned later in life?

   Yes, if motivation and time are available. e.g., computers.

4. Rewards of technological literacy.

   - Personal satisfaction of knowing what goes on in the world.
   - Increase in feelings of adequacy about being responsible for major social decisions.
   - Understanding of one's own body and health.
   - Pass literacy and the habits to maintain it on to the next generation. It grows with time in a society.

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"THE BRAIN"
HIGH SCHOOL MATERIALS

Presenters: **Cathy Cevoli - WNET/Thirteen**
Linda Lilienfeld - WNET/Thirteen

This program was a presentation of teacher and student curriculum materials being developed by WNET to assist high school teachers utilize the public television series, "The Brain." The presentation was an example of the use of a technology (TV tapes) in the classroom to enhance the learning of science and technology.

"The Brain" has been considered to be a no-nonsense documentary about that expansive, undulating, electrochemical wetland called the brain - what we know about how it works, how we came to know those things, and what we still don't know. It is also about uniqueness, a survey of those properties and qualities that make the human brain different from that of any other species. By the time the eight-part foray into the neural sciences ends, it is abundantly clear that the brain is our badge of humanity.

Ultimately the main point of "The Brain" is instruction. It is fair to say that the neural sciences, like many other medically related sciences, grew as much through the accumulation of case histories as through pure neuro-biological research, technological innovation, or theoretical insight. Thus, this series illuminates the structures, functions, and organization of the brain as much through case histories as through reports on research, technology, or attempts at a unified theory of the brain. Each is instructive, each a component of superb documentary television.

How we use technology in the classroom is a major factor in our teaching about technology. Use it properly and appropriately and we teach positive attitudes toward the use of technology for "good." Just use it and we teach a carelessness concerning technology that just permeates our students' minds. Science teachers must be involved in preparing instructional materials to use with TV tapes, video disks, and computer devices. Only then will we maximize their value in instruction and teach with technology to meet our educational objectives.

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A FUNDED NEW JERSEY JUNIOR HIGH/MIDDLE SCHOOL SCIENCE/TECHNOLOGY TEACHING PROJECT

Presenters: **Dr. Mark O'Shea**
Fairleigh Dickinson University
Dr. Howard Kimmel, Associate Chairman
Chemistry Division, N.J. Institute of Technology

The Center for Pre-College Programs at New Jersey Institute of Technology and Dr. Mark O'Shea of Fairleigh Dickinson's College of Education have engaged in a project funded by the State Department of Higher Education to bring direct services for curricular development to middle school and junior high school science teachers in the northern region of New Jersey. The curricular materials being implemented consist of several enrichment packets developed and funded through the American Association for the Advancement of Science. These packets, which deal with phenomena and concepts of the physical and biological sciences, are entitled:

Science Resources For Schools

Science Resources for Schools is presently being distributed in Florida, Colorado, North Carolina, and Ohio. The distribution of these materials through NJIT and FDU is part of a special project to determine the effectiveness of utilizing microcomputer base telecommunications to assist teachers in their efforts to implement programs materials.

Six long workshops, held approximately at six-week intervals, are used to perform the following tasks:

1. Teachers are given the opportunity to actually perform the Science Resources for Schools activities developed for students by nationally recognized museums in similar institutions throughout the country.

2. Teachers are given an opportunity to critique the activities after performing them, with specific emphasis given to modifications in activities that may be necessary in order to present them in a classroom as a scientific investigation with some structure.

3. Theoretical underpinnings of the Science Resources for Schools activities are presented and discussed with participating teachers.

4. Opportunity is given to participants to perform additional activities not developed by Science Resources for Schools but in support of the concepts and skills that are in SRS.

In addition to the telecommunication services and workshops, there is a third component which supports teacher implementation of the Science Resources for Schools materials. This third component consists of school visits by members of the Higher Education Institution team that are designed to elevate the value of this project as perceived by administrators and policy makers of the school districts where teachers are employed.

When difficulty in establishing telecommunications is experienced or in situations where participating teachers find the bureaucratic structure of their school setting in itself to be resistant to the proper conduct of this project activities, school visits by project director help to facilitate the local implementation in a way that very often teachers cannot bring about by themselves.

It is the belief of New Jersey Institute of Technology and Fairleigh Dickinson University that direct services of these kinds to teachers are essential if change is to be made that would benefit children

in our schools. Anyone having questions with regard to this project may feel free to contact Professor Howard Kimmel of New Jersey Institute of Technology or Dr. Mark O'Shea of Fairleigh Dickinson University.

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THE QUALITY OF LIFE - THE TECHNOLOGY OF RESPIRATORY THERAPY

Presenter: Sam Burko, Metropolitan Respiratory Service

Mr. Burko not only gave some specific examples of how technology has increased the quality of life for so many people, but posed the problems of decision making and values clarification in specific situations such as a "brain-dead" patient kept alive by respiratory technology. The more technology can do, the more we must decide what should be done. This goes beyond science and into philosophy-religion-values and we must make our students aware of these problems.

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YOUR ELECTRONIC BALANCE AND YOUR COMPUTER

Presenter: Mary A. Garside, Ohaus Corporation

Interfacing of the computer with scientific measurement devices is a way to teach laboratory technology usage with limited funds. The computers are there . . . or they are coming. We can interface and process information from time/distance/acceleration measurements, pendulum studies, temperature studies, human physiology experiments, light and electrical/magnetism studies, pH studies, and potentiometric titrations, etc.

This program was a demonstration of an innovative educational software package that connects an Ohaus electronic balance and an Apple Computer for weight and measurement experiments. There are three interactive programs on one disk covering weight, statistical and time weight applications. This software provides expanded functioning of an electronic balance for high school laboratory and classroom work. Discussion covered other possible activities that can be developed in this area.

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SCIENCE TEACHERS AND SCIENTISTS INTERACTION PROJECT

One extremely successful program that brings teachers into industry, gives them experience in the "cutting edge" of their science discipline, and then brings that experience back to the schools is the Science Teachers and Scientists Interaction Project.[2]

The project goal is to create a program of activities involving interactions between members of a consortium of secondary schools and science/technology industries. The purposes of the project include:

1. To extend to science teachers an experience in industry to update understandings of applications of scientific principles.

2. To gather information that will be used to upgrade the science curricula taught in the schools of those teachers.

3. To establish an outreach program for industry whereby it can have an effective input into the schools.

4. To create a self-sustaining network of communication between schools and industries.

The project outcomes include:

1. Gain an understanding of the role of scientific industries in society.

2. Gain content information about these industries.

3. Obtain extensive career information for use with students.

4. Become more aware of the applications of scientific principles.

5. Gain first hand experience, through hands-on activities of how technology and research and development occur in industry.

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[2]Thomas Ritter, Project Director, Science Teachers and Scientists Interaction Project, West Windsor-Plainsboro High School, 346 Clarksville Road, Princeton Junction, N.J., 08550.

6. Establish a group of teachers who will act as master teachers in industry-school relations.

The participating agencies in this project are from a limited geographic region - Mercer County, N.J., and the surrounding area - and serve first teachers in the same area. The project participants include local school boards and selected teachers and scientists and other personnel from industries, universities and government agencies involved with science/technology research and/or application.

This project was conceived and implemented by Thomas Ritter, a secondary school physics teacher in Mercer County, with considerable aid from school and industry personnel. The sequence of activities which follow has been run successfully in Mercer County. A two-day seminar involved eight public school districts and one private school. The summer internships were run for two years involving seven school districts and industries the first year and eight the second.

This project is easily adaptable to any community of schools having scientific or engineering facilities in reasonable proximity to them.

After identifying a cooperative group of schools and industries and evaluating curriculum needs and industry resources, a minimum of a two-week hands-on experience in industry is arranged for each teacher involved. One or two weeks are also given the teacher to develop their experience into teaching modules on science careers and content topics to be used by all teachers in the area. Teachers who went through the program present workshops to other science teachers from participating schools. The workshop includes a summary of the teacher's experience, an introduction to the contents of the teaching module, and suggestions as to how and where to implement it.

Each teacher is expected to develop a teaching module on the industry visited. This module will be recorded in a bound notebook and it will include:

1. Background information about the particular type of industry (to be obtained prior to the visit). This pre-visit research will include appropriate questions to be asked while on site.

2. A detailed written description of the industry, obtained from the on-site visit: including answers to specific questions, descriptions of particular engineering processes and chemical and physical processes employed.

3. A discussion of obstacles overcome through engineering advancements, and a listing of problems yet to be overcome.

4. A detailed listing of scientific principles and theories applied by the industry, and a description of how each is applied.

5. Any recent changes in the process(es) employed to keep up with more recent knowledge and with economic considerations.

6. A description of factual information, obtained from each industry, that can be incorporated into the teacher's future teaching of science.

7. A detailed presentation of career education information including brochures, forms, personal analyses, opportunities, future potential, etc.

8. As participants, each teacher will have responsibility for the following:

   - Comply with all rules, regulations, and procedures of the host facility with which he/she will be involved.

   - Attend orientation programs specifically organized by the industry for his/her benefit.

   - During the industrial experience, seek out information in the areas of concern to the project which will improve the science curriculum and help achieve the purpose and objectives of the project.

   - Give adequate time necessary to complete the tasks assigned.

   - Work with the project faculty and the other participants to develop curriculum materials which will comply with the standards and format set down by individual school districts.

   - Share the curriculum materials with other colleagues whose classes would benefit from the information.

During the summer of 1984, eight science teachers from different schools interned at nine different field locations.

Three of the ten teaching modules produced from the Summer Program 1984 include:

1. Fusion Energy - Engineering Aspects.

2. Pesticides: From Laboratory To Commercial Use.

3. Diagnostic Procedures For Urinalysis And The Manufacture Of Diagnostic Reagents.

A review of the above three manuscripts indicated outstanding teacher work and college/industry cooperation and aid. The modules are written in a manner that can be used by many teachers, especially those who attend the presentation meeting(s) to best understand the philosophy and objectives of the modules.

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DISCUSSION/BRAINSTORMING SESSIONS

Leaders: **Audrey Brainard, Georgian Court College; Sr. Shirley Corbliss, Science High School, Newark; Elmer Dey, Randolph High School; Jim Gardner, Millburn High School; Leonard Blessing, Millburn Schools; Gloria Lehman, Middletown North High School; Jim Messersmith, Princeton Regional Middle School; Sr. M. Nicholas Farley, Georgian Court College; Robert De Blasi, Paramus Public Schools**

After the presentations by our speakers, small discussion groups were formed to brainstorm questions addressed at the conference. Since all discussion groups started with the same questions, the following gives the concensus of the groups.

Question: What is technological literacy?

Answer: Technological literacy is the ability to cope with everyday issues, to analyze a problem from both sides.

Process skills of science should equip students with knowledge needed to make wise decisions. Technology might be defined as anything which permits an individual to go beyond his/her senses, e.g., the magnifier or electron microscope. Technological literacy includes knowing the vocabulary necessary to understand written science and understanding the principles of the working of instruments. It means that students, both "science" and "non-science," are able to apply concepts to their

own lives and situations. It means applying science and technology in group reactions: team work for the common good rather than working alone. Technological literacy may be taught through current topics, those which are vital for the day, e.g., heart transplants, explanation of AIDS. The topics are much broader than just a computer. We say a person is technologically literate if he/she can listen to an explanation about how a thing works, can then write about it, question it, be comfortable with it. We define one technologically literate if he/she uses an active process of problem solving, is able to research it, is able to form an opinion, express it, communicate; and has an idea of the processes which led to this particular technology.

Question: How do we teach it to all students K-12? What do we teach? When?

Answer: Less time should be spent in teaching facts, more time on problem solving. Time should be taken to debate controversial issues. The curricula should be narrowed and a more indepth approach taken. All students should become technologically literate, but not at the expense of producing scientists and engineers.

The curriculum should be more interesting, less memorization, more investigations and gathering of data, more thinking of the meaning of the data. Use topics of interest to students.

The laboratory provides data and interest, it is the core of the science program. The literate, motivated teacher is essential to science education. To this end, find time for improving science skills of teachers.

We can have secondary teachers help the elementary teachers through classroom lessons or workshops.

Along with teaching science and technology, it is necessary to be aware of safety hazards both in the school room and in the environment. Students need to be aware of the effects of technology, both good and evil, on their lives. How do they cope?

Question: How do we utilize technology in our every day teaching to best develop technological literacy?

Answer: We use a variety of teaching strategies including the media, field trips, speakers from industry, instrumentation, lessons, and career awareness. We become computer literate only when the computer is essential to problem solving, e.g., in the chem lab when no other technology will let us get the answer quickly, accurately.

What is best to develop technological literacy? It is almost impossible to keep up. And what do we teach about the new problems new technology brings with it?

At the elementary level, concepts to be taught should stem from experiences that children are familiar with or can investigate for themselves. Throw the book away!

The curriculum should take pupils from the known to the unknown with practical application of concepts taught to their daily life.

Technology can be used to teach science principles, process skills, the relationship between science and technology, and the impact of both on the social structure. When discussing technology, the focus should not be on equipment since it becomes obsolete so quickly, but rather students should develop an understanding of how technology influences society as well as how society influences technology. Students should not be led to believe that science can solve all problems. The use of the most recent technological invention in the classroom can detract from the content, process skills and attitudes which need to be developed. The use of the "black box" is not nearly so important as the principle of science that allows it to work.

M.B.

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THE NSTA DEFINITION OF SCIENTIFIC AND TECHNOLOGICAL LITERACY

The National Science Teachers Association Definition of Scientific and Technological Literacy can be used as a guide to a set of general objectives.

A technologically literate person:

- Uses science concepts, process skills, and values in making responsible everyday decisions.
- Understands how society influences science and technology as well as how science and technology influence society.

- Understands that society controls science and technology through the allocation of resources.

- Recognizes the limitations as well as the usefulness of science and technology in advancing human welfare.

- Knows the major concepts, hypotheses, and theories of science and is able to use them.

- Appreciates science and technology for the intellectual stimulus they provide.

- Understands that the generation of scientific knowledge depends upon the inquiry process and upon conceptual theories.

- Distinguishes between scientific evidence and personal opinion.

- Recognizes the origin of science and understands that scientific knowledge is tentative, and subject to change as evidence accumulates.

- Understands the applications of technology and the decisions entailed in the use of technology.

- Has sufficient knowledge and experience to appreciate the worthiness of research and technological development.

- Has a richer and more exciting view of the world as the result of science education.

- Knows reliable sources of scientific and technological information and uses these sources in the process of decision making.